

Computer simulation

- From class web page in lab sections open **“PhET Gas Laws Simulation”**
- Launch the simulation

URL:

<http://phet.colorado.edu/en/simulation/gas-properties>

-OR-

- Google: “gas law PhET simulation”

Before you answering questions...

That you can...

1. Add both heavy and light gases to the container
2. Adjust the temperature of the container while holding the pressure constant
3. Decrease the volume of the container

PhET Gas Simulation Turn In

Answer all question on separate sheet of paper labeled “PhET Gas Simulation”

Compose a properly formatted email to send graphs saved to a single sheet as a pdf. and forward to Mr. Golden by 12:30pm 6.Mar.2018. Save pdf. as follows, “pX.FirstLast.phetgaslaws1718”

BELL WORK, 2-Mar-2018

Write a balanced equation for the reaction below:

Zinc and hydrochloric acid react to form Zinc (II)
Chloride and Hydrogen gas

In series of trials a student recorded the following data
when reacting Zinc and Hydrochloric acid

	Trial A	Trial B
Mass of Zinc (M.M. 65g/mol)	5.00g	10.0g
Moles of Zinc		
Mass of HCl (M.M. 36g/mol)	15.0g	18.0g
Moles of HCl		
Mole ratio of zinc to HCl		
What is the Limiting reagent		
Moles of H ₂ gas formed		

Agenda

Pressure units and Kelvin

Objective

You will be able to convert between different pressure units.

What is pressure?

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

Units of Pressure

$$1 \text{ pascal (Pa)} = 1 \text{ N/m}^2$$

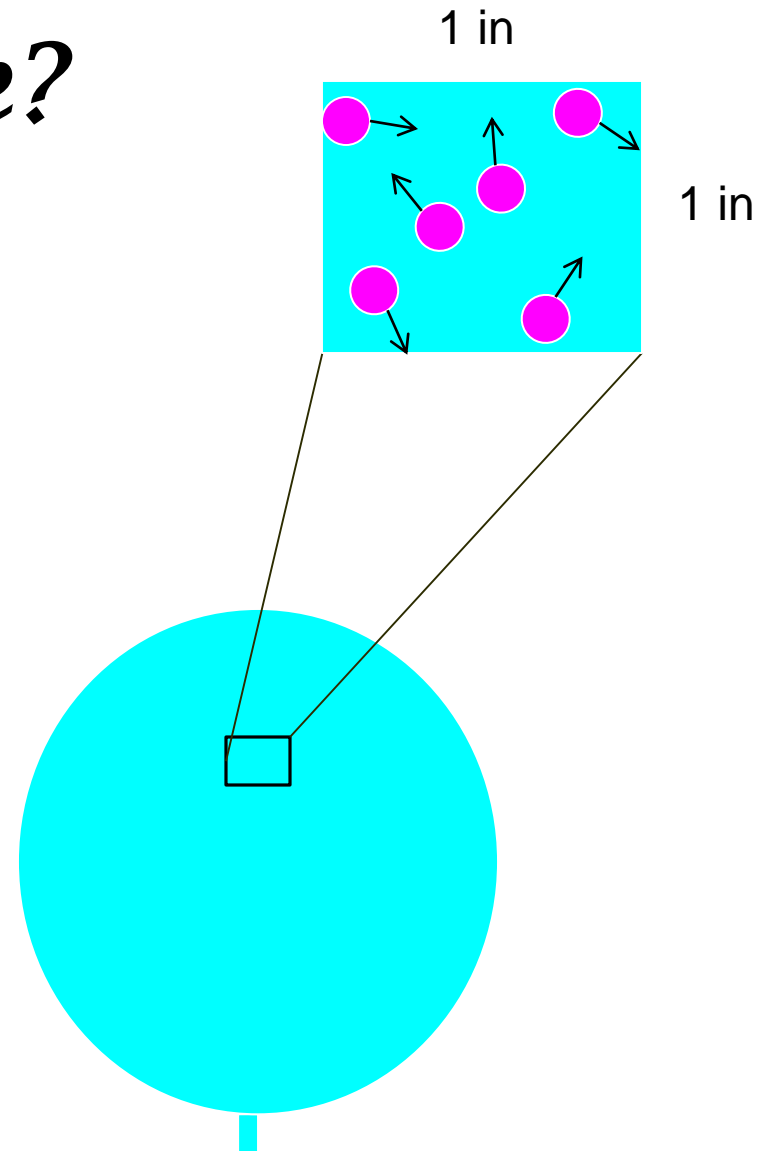
$$1 \text{ atm} =$$

$$760 \text{ mmHg} =$$

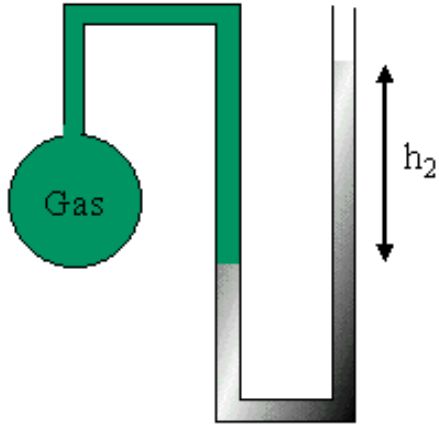
$$760 \text{ torr} =$$

$$101.325 \text{ kPa} =$$

$$14.7 \text{ psi}$$

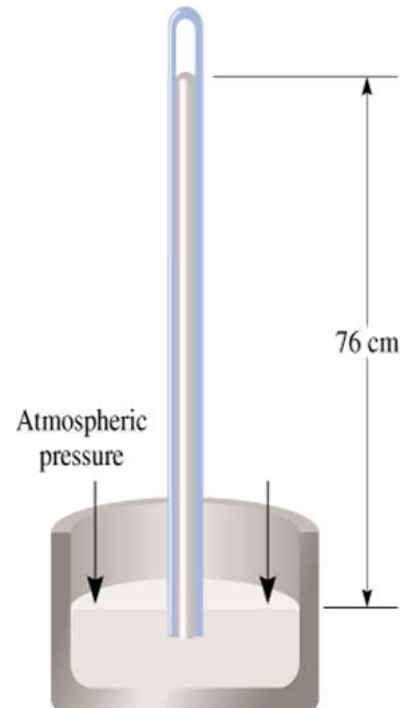


How do we measure pressure?

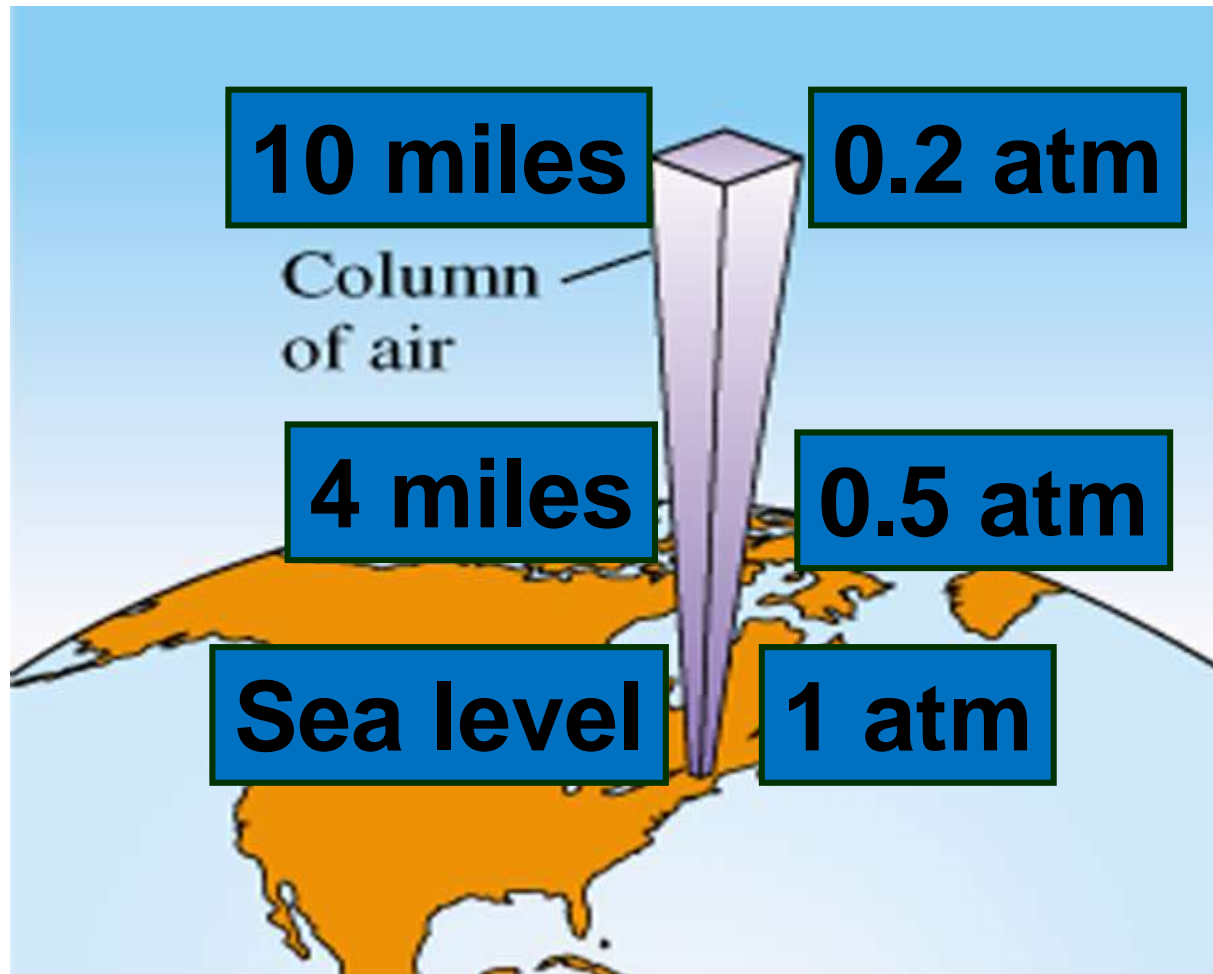


A manometer uses a U-shaped tube of liquid to measure pressure differences on either side of the liquid

A barometer uses the height of a column of mercury to measure gas pressure in mmHg



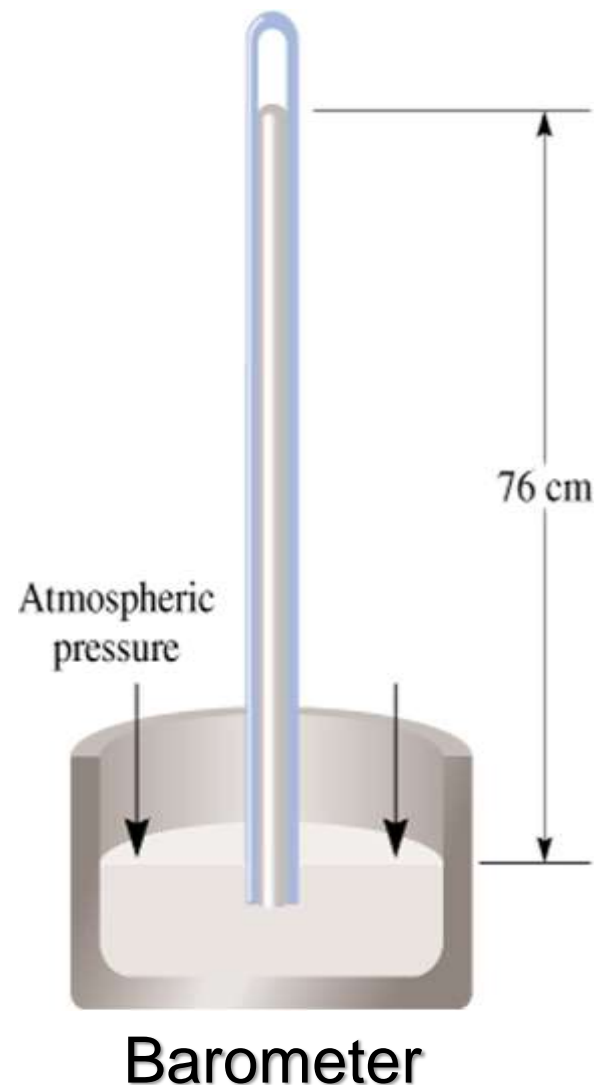
What is the pressure in mmHg at sea level?
What is the pressure in Pascals at sea level?



Try this...

Convert:

- 1. 727 mmHg into kPa**
- 2. 52.5 kPa into atm**
- 3. 0.729 atm into mmHg**
- 4. 522 torr into kPa**
- 5. 800.0 mmHg into atm**
- 6. 495Pa into mmHg**



Standard Temperature and Pressure

Standard temperature and pressure (**STP**) refers to nominal conditions in the atmosphere at sea level. This value is important to physicists, chemists, engineers, pilots and navigators. Why?

Temperature = 0° C or 273K

Pressure = 1atm

All temperature must be converted to Kelvin

To convert $^{\circ}\text{C} \rightarrow \text{K}$

$$T (\text{K}) = t (^{\circ}\text{C}) + 273$$

To convert $\text{K} \rightarrow ^{\circ}\text{C}$

$$T (^{\circ}\text{C}) = t (\text{K}) - 273$$

Why is the Kelvin scale used exclusively in gas law calculations?

BELL WORK

5-Mar-2018

~~Log onto a computer and sign into Mozilla or Chrome.~~

~~Go to class web page and open the lab section.~~

~~While you wait for computer to load complete the following:~~

Solve the following equation for V_2 :

$$P_1 V_1 = P_2 V_2$$

What is the equivalent pressure for a tank of compressive gas at 2.8atm if you are asked to report value in mmHg?

Computer simulation

Agenda

Objective

To explore how gases are affected by different variables using a computer simulation

BELL WORK *5-Mar-2018*

Draw three different balloons with air particles in them

1. One full of gas at room temperature

2. One full of gas at 0 °C (~32 ° F)

3. One full of gas at 50 °C (~122 ° F)

- Using dots show particles inside each of the balloons (Keep number of particles (“n” moles) constant between Balloons)
- Use arrows to indicate how fast they are moving (longer arrow = faster)
- Rank the balloons from lowest to highest pressure

EQ: Where else in life do we make assumption to simplify a situation?

Agenda

Gas properties and the KMT

Objective(s)

To explain properties of gases using the kinetic molecular theory

To explain to a group of peer one of the tenitis of the KMT of gasses.

Try it

Using the gas law formula for changing volume and temperature while holding moles and pressure constant solve for T_2 .

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Gas Law Problems #1

#1-16 due (show all work) 7Mar2018

Skip Numbers #3, 7, 9, 17-20 for now.

EQ: Where else in life do we make assumption to simplify a situation?

Agenda

Gas properties and the KMT

Objective(s)

To explain properties of gases using the kinetic molecular theory

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Demo

Write on your bellwork what you predict is going to happen

Write down what you actually observed

PhET Gas Law Simulation

Pass it forward, time
to turn in

Boyles ($P_1V_1 = P_2V_2$) and Charles Law ($V_1/T_1 = V_2/T_2$)

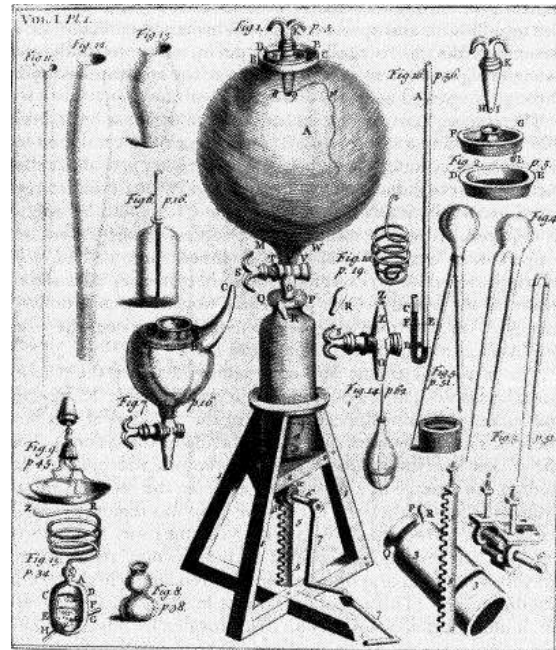
.If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm?

A gas sample at 40.0°C occupies a volume of 2.32 L. If the temperature is raised to 75.0°C, what will the volume be, assuming the pressure remains constant?

Closure

What are three (3) assumption made in the KMT of gasses regarding gas behavior and properties

Boyle's Law



**What is the relationship
between pressure and volume if
temperature and moles are held
constant?**

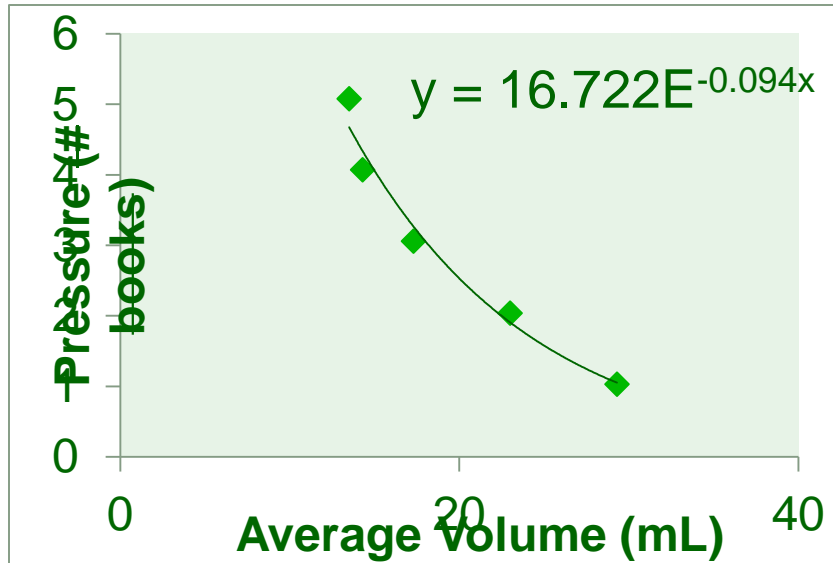
Boyles ($P_1V_1 = P_2V_2$) and Charles Law ($V_1/T_1 = V_2/T_2$)

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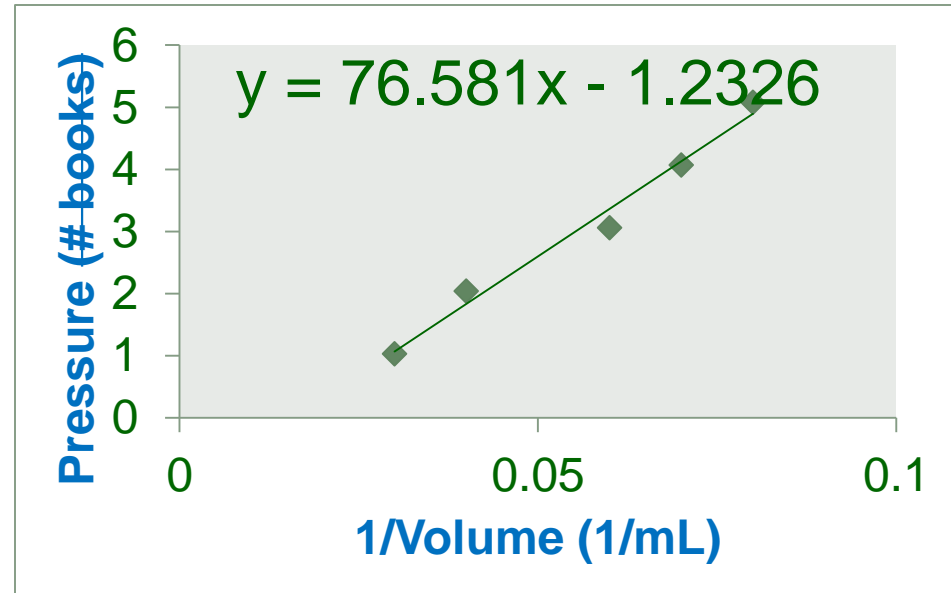
A gas sample at 40.0°C occupies a volume of 2.32 L. If the temperature is raised to 75.0°C, what will the volume be, assuming the pressure remains constant?

Boyle's Law, Data Analysis

Volume v. Pressure



1/Volume v.



When graphing V vs. P the slope is exponential (instantaneous/ not constant) so when we re-graph as V^{-1} vs. P we get a linear slope (constant)

Boyle's Law

In a system in which the amount of gas in a system stays the same and the temperature remains constant:

$$\mathbf{P_1 V_1 = P_2 V_2}$$

P_1 and P_2 must be in the same units

V_1 and V_2 must be in the same units

Now Try This

At STP a sample of nitrogen takes up a volume of 50L. What is the new volume if the pressure is changed to 220 mmHg.

$$V_2 = ?$$

$$P_2 = 220\text{mmHg} \times \frac{1\text{atm}}{760\text{mmHg}} = 0.289\text{atm}$$

$$P_1 V_1 = P_2 V_2$$

$$P_1 V_1 / P_2 = V_2$$

$$V_1 = 50\text{L}$$

$$P_1 (\text{STP}) = 1\text{atm}$$

$$(1\text{atm})(50\text{L}) / (0.289\text{atm}) = V_2$$

$$173\text{L} = V_2$$

Elements that exist as gases at 25°C and 1 atmosphere

[illegible]

Table 5.1 Some Substances Found as Gases at 1 atm and 25°C

Elements	Compounds
H ₂ (molecular hydrogen)	HF (hydrogen fluoride)
N ₂ (molecular nitrogen)	HCl (hydrogen chloride)
O ₂ (molecular oxygen)	HBr (hydrogen bromide)
O ₃ (ozone)	HI (hydrogen iodide)
F ₂ (molecular fluorine)	CO (carbon monoxide)
Cl ₂ (molecular chlorine)	CO ₂ (carbon dioxide)
He (helium)	NH ₃ (ammonia)
Ne (neon)	NO (nitric oxide)
Ar (argon)	NO ₂ (nitrogen dioxide)
Kr (krypton)	N ₂ O (nitrous oxide)
Xe (xenon)	SO ₂ (sulfur dioxide)
Rn (radon)	H ₂ S (hydrogen sulfide)
	HCN (hydrogen cyanide)*

* The boiling point of HCN is 26°C, but it is close enough to qualify as a gas at ordinary atmospheric conditions.

Having a hard time with gas law word problems? Try this...

Problems dealing with only one species and a change in conditions – this set up can help keep track of all variables and values.

Remove the constants, and the remaining variables leaves the correct formula (**Boyles**, **Charles**, **Avogadro's**, **Gay-Lussac's**, or **Combined**)

1. What you want?

2. Given Information

$$P_1 = \quad P_2 =$$

$$V_1 = \quad V_2 =$$

$$T_1 = \quad T_2 =$$

$$n_1 = \quad n_2 =$$

4. Plan

5. Calculations for solutions

3. Useful formulas/
conversions

$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$

6Mar18

Bell Work Using “Box Method”

- a. 4.35 L of a gas is at 1.16 atm. What pressure is obtained when the volume is 9.3 L and the temperature remains constant at 25°C?
- b. How is the speed of gas particles related to temperature of the gas. Be sure to describe in terms of E_K (kinetic energy)?

1. What you want?

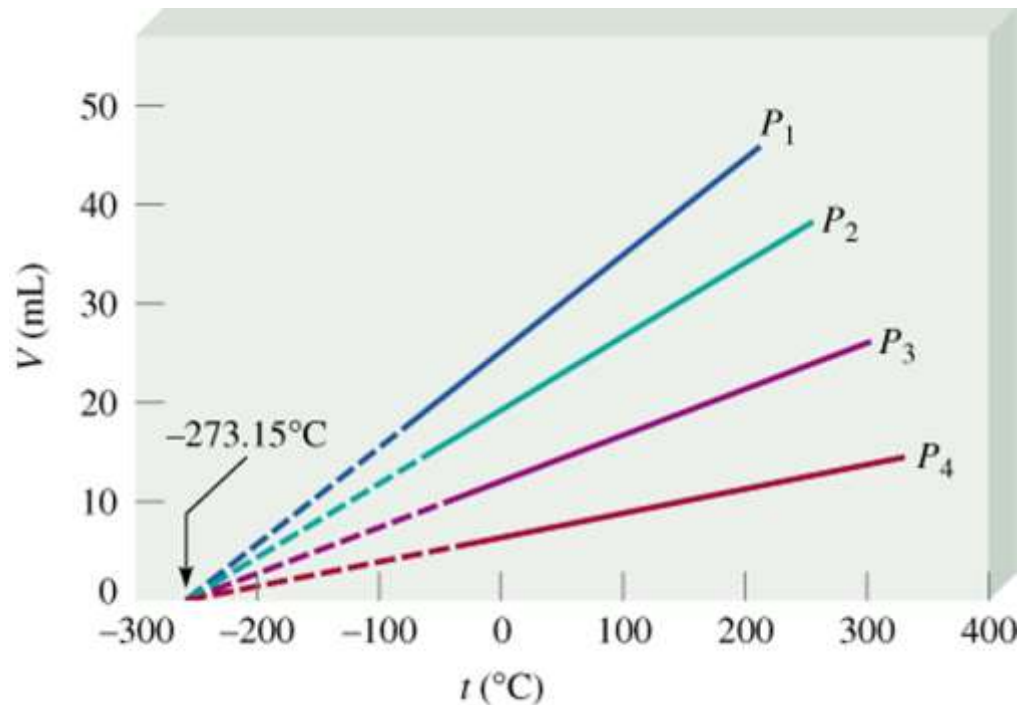
2. Given Information

4. Plan

5. Calculations for solutions

3. Useful formulas/
conversions

Charles law?



Charles' Law

$$V \propto T$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\% \text{ Error} = \left| \frac{\text{Theoretical Value} - \text{Experimental Value}}{\text{Theoretical Value}} \right| \times 100$$

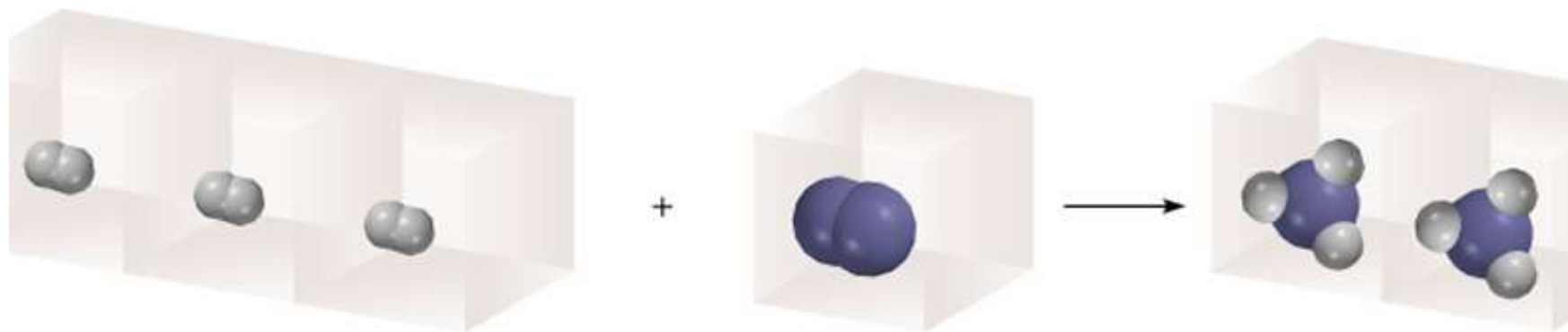
Avogadro's Law

$V \propto \text{number of moles } (n)$

$$V = \text{constant} \times n$$

Const. Temp.
Const. Pressure

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$



$3\text{H}_2(g)$

3 molecules

3 moles

3 volumes

+

+

+

+

$\text{N}_2(g)$

1 molecule

1 mole

1 volume

→

→

→

→

$2\text{NH}_3(g)$

2 molecules

2 moles

2 volumes

What do we know so far?

With a constant amount of particles in a sample of gas...

Boyles law

$$P_1 V_1 = P_2 V_2$$

Charles law

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Gay-Lussac's Law

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Avogadro's Law

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

How can we put it all together to determine relationships between all three?

Combined Gas Law!

When the number of gas particles in the system remains constant:

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}$$

Rearrange the equation for:

- 1. T_1**
- 2. P_2**